

Department of Defense FY 2012 Climate Change Adaptation Roadmap

The Department of Defense (DoD) Climate Change Adaptation Roadmap (CCAR) fulfills a requirement of Executive Order 13514, *Federal Leadership in Environmental, Energy and Economic Performance*. All Federal Departments and Agencies should evaluate climate change risks and vulnerabilities to manage both the short- and long-term effect of climate change on the agency's mission and operations, and include an adaptation planning document as an appendix to its annual Strategic Sustainability Performance Plan.

1. Policy Framework for Climate Change Adaptation Planning

The foundation for DoD's strategic policy on climate change adaptation began with the publication of the Quadrennial Defense Review (QDR) in 2010 by the Secretary of Defense. The QDR is a principal means by which the tenets of the National Defense Strategy are translated into new policies and initiatives. The QDR sets a long-term course for DoD as the Department assesses the threats and challenges that the nation faces and re-balances DoD's strategies, capabilities, and forces to address today's conflicts and tomorrow's threats. The QDR acknowledged that climate change has national security implications and must be addressed by DoD and its partners.

The QDR recognized that climate change will affect DoD in two broad ways.

- First, climate change will shape the operating environment, roles, and missions that the Department undertakes. It may have significant geopolitical impacts around the world, contributing to greater competition for more limited and critical life-sustaining resources like food and water. While the effects of climate change alone do not cause conflict, they may act as accelerants of instability or conflict in parts of the world. Climate change may also lead to increased demands for defense support to civil authorities for humanitarian assistance or disaster response, both within the United States and overseas.
- Second, DoD will need to adjust to the impacts of climate change on its facilities, infrastructure, training and testing activities, and military capabilities. DoD's operational readiness hinges on continued access to land, air, and sea training and test space, all of which are subject to the effects of climate change.

Through its planning and adaptation actions, DoD will be better prepared to effectively respond to climate change and to ensure continued mission success, both in the near term and in the future.

As climate science advances, the Department will need to regularly reevaluate climate-related risks and opportunities in order to develop policies and plans that manage climate change's impacts on the Department's operating environment, missions, and facilities. Managing the national security implications of climate change will require DoD to work collaboratively, with both traditional allies and new partners.

"Our mission at the Department is to secure this nation against threats to our homeland and to our people. In the 21st Century, the reality is that there are environmental threats which constitute threats to our national security. For example, the area of climate change has a dramatic impact on national security: rising sea levels, to severe droughts, to the melting of the polar caps, to more frequent and devastating natural disasters all raise demand for humanitarian assistance and disaster relief."

Secretary Leon E. Panetta, May 2, 2012

1.A Vision and Goals

As articulated in the Department's Strategic Sustainability Performance Plan, DoD's sustainability vision is to maintain our ability to operate into the future without decline, either in the mission or the natural and man-made systems that support it. Including climate change and climate variability considerations in our planning processes will enhance operational and infrastructure resilience.

Four broad goals support the Department's vision, as detailed below; implementation is discussed in Section 3.

1. Define a coordinating body to address climate change.
2. Utilize a robust decision making approach based on the best available science.
3. Integrate climate change considerations into existing processes.
4. Partner with Federal agencies and allies on the challenges of climate change.

"Our ability to advance constructive cooperation is essential to the security and prosperity of specific regions, and to facilitating global cooperation on issues ranging from violent extremism and nuclear proliferation, to climate change, and global economic instability-issues that challenge all nations, but that no one nation alone can meet." (pg 11)
— 2010 National Security Strategy

1.B Responsible Senior Agency Official

The Department's Senior Sustainability Officer (SSO) is the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(ATL)) and is responsible for overseeing the implementation of the requirements of Executive Order 13514, including climate change adaptation efforts. The Deputy Under Secretary of Defense for Installations and Environment (DUSD(I&E)) is the Department's Senior Climate Official and reports progress to the SSO. Given the broad range of potential impacts to the Department's operational, training, and test and infrastructure capabilities, the Department will analyze how climate change adaptation measures can be incorporated into the full scope of its missions and operations.

2. Agency Vulnerability: Analysis of Climate Change Risks and Opportunities

Climate change is expected to play a significant role in DoD's ability to fulfill its mission in the future. Climate-related effects already are being observed at DoD installations throughout the U.S. and overseas. The physical changes are projected to include rising temperature and sea level and increases in both heavy downpours and the extent of drought. These will cause effects such as more rapid coastal erosion, shifts in growing seasons, and changing water tables.

The direction, degree, and rates of the physical changes will differ by region, as will the impacts to the military's mission and operations. By taking a proactive, flexible approach to vulnerability assessment and adaptation planning that recognizes uncertainty and incorporates the best available science, the Department can keep pace with changing climate patterns and minimize their impact on operations.

The military is potentially vulnerable to climate change in many of the same ways as the rest of society, and in ways that are unique due to its operations and mission. The following table summarizes the potential high-level climate change impacts to the Department's mission and operations. More comprehensive and region/installation-specific vulnerability assessments are needed to determine what adaptive responses are the most appropriate.

Table 1. Climate Phenomena and Potential DoD Mission Vulnerabilities

Climate Change Phenomena	Potential Impacts	Potential Mission Vulnerabilities
Rising temperatures	Rising mean temperatures; seasonal temperature increases; increased number of cumulative days with temperatures exceeding 95°F; opening of Arctic waters; melting permafrost and ice sheets; lengthening ice-free seasons; human health effects ; vegetation transition (species and biome shifts); changes in incidence/distribution of vector-borne diseases; wildfire risk; soil warming; electrical grid stress; equipment performance	Increased occurrence of test/training limitations due to high heat days; reduced military vehicle access (e.g., melting permafrost); degrading infrastructure and increased maintenance costs for roads, utilities, and runways; reduced airlift capacity; reduced live-fire training; potential degradation or loss of cold weather training venues; increased energy costs for building and industrial base operations; increased operational health surveillance and risks; change in operational parameters for weapons and equipment development and testing; increase in seasonal Arctic commerce and transit
Changes in precipitation patterns	Seasonal increases and decreases in precipitation; increases in extent and duration of drought; increases in extreme precipitation events; changes in number of consecutive days of high or low precipitation; change in form of precipitation (i.e., snow-ice-rain); increased wildfire risk; altered burn regimes; impacts to air quality; stream bank erosion and gulying of vegetative cover; impacted soil function and resilience (desertification); soil loss; infrastructure damage; water supply constraints; impacted groundwater quality; increased dust; protected species stress and potential for more species placed at risk; spread of invasive species; changes in incidence/distribution of vector-borne diseases; land management impacts; competing non-military land use	Reduced land carrying capacity for vehicle maneuvers; increased maintenance costs for roads, utilities, and runways; limits on low-level rotary wing flight operations; icing on aircraft; increased regulatory constraints on training land access; reduced live-fire training; reduced water availability and greater competition for limited water resources; reduced training land access; reduced training carrying capacity; operational health surveillance and risks; increased flood control/erosion prevention measures
Increasing storm frequency & intensity (coastal and inland)	Flooding; water quality issues; soil and vegetation loss; impact to soil function and carbon/nutrient cycling; wind damage	Military personnel safety; temporary or prolonged disruption of military operations or test and training activities due to intense storms and resulting storm damage; inundation of and damage to coastal infrastructure; reduced access to military water crossings and river operations; reduced off-road maneuver capacity; increased maintenance costs; increased flood control/erosion prevention measures; transportation infrastructure damage

Climate Change Phenomena	Potential Impacts	Potential Mission Vulnerabilities
Rising sea levels & associated storm surge	Loss of coastal land; damage to physical infrastructure (roads, targets, ranges) and protected ecosystem resources; saltwater intrusion; reduced capacity of protective barrier islands and coastal wetlands	Degradation or loss of coastal areas and infrastructure; increased cost of infrastructure reinforcement to withstand increased storm intensities; increased cost of infrastructure modification (e.g., raising pier heights); impacts to littoral and shore training and ranges; increased regulatory constraints on training land access; impacts on supply chain from potential shipping interruptions; increased demand for freshwater resources and associated increased cost of saltwater intrusion countermeasures; impact to future land availability and siting of new construction
Changes in ocean temperature, circulation, salinity, and acidity	Potential greater change to global climate system; negative impacts to general populations that rely upon fish as their main source of protein; coral reef losses that may impact ocean productivity and storm surge/wave dampening benefits	Exacerbation of conditions and mission impacts discussed above; coastal installation vulnerability; regional instability; increased potential for conflict or humanitarian assistance

3. Process for DoD Adaptation Planning and Evaluation

The QDR provides broad direction for future DoD strategies that will define plans and policies. Prompted by the QDR, the Department is prudently considering how to factor climate impacts into its mission areas. Given the diversity and complexity of DoD's mission and operations, there is an equally wide array and magnitude of planning processes across DoD. The Department recognizes that both operational and infrastructure plans and processes present opportunities to integrate climate change risks and opportunities to enhance the resilience of our mission, at home and abroad.

DoD is well-versed in employing systematic methodologies and modeling frameworks in order to assess potential threats and risks to national security. The use of these risk assessment tools is an essential element of accomplishing the DoD mission. The Department anticipates employing a similar risk-based approach to evaluate multiple scenarios of potential climate change effects on the DoD mission. Many of the Department's current efforts are focused on assessing potential climate change impacts to, and adaptation strategies for, facilities, built infrastructure, key ecosystems and protected species, and capabilities where military training is conducted or supported, and evaluating potential actions DoD can take to respond to these impacts. Sections 4 and 5 discuss specific efforts.

DoD intends to move forward with the previously stated goals for adaptation planning and evaluation. Goal implementation is described below.

"Preventing wars is as important as winning them, and far less costly." (pg 7)
— 2011 National Military Strategy

Goal 1: Define a coordinating body to address climate change.

The Department intends to define an appropriate structure utilizing existing bodies and organizations within DoD to guide the development, implementation, and evaluation of climate-related policy, guidance, and practice. The Senior Sustainability Council (SSC) is currently responsible for coordinating climate change adaptation efforts. The SSC will establish a technical advisory committee or working group to take direction from and provide advice to the council regarding the state of climate science, vulnerability and impact assessment, and adaptation science and practice. The advisory committee will analyze technical constraints and considerations related to climate change-related policy, guidance, and practice. The advisory committee will focus on ensuring that the Department has access to the climate-related information necessary to make informed decisions that support the Department's mission. This structure would identify those offices and existing forums, with authority in this area, those that would assist in coordination and guidance, and those that would be involved in support and implementation.

The advisory committee, once established, will:

- Optimize use of existing plans and processes and identify gaps where new policies could be developed;
- Stress the importance of the science-policy interface;
- Foster sound vulnerability and impact assessment;
- Emphasize iterative and adaptive policy and planning approaches; and
- Monitor assessment and adaptation implementation effectiveness, learn from these experiences, and adjust action when needed.

The DSB recommended the Secretaries and Chiefs of the Services should: better integrate climate change and disaster risk reduction consideration into exercise, training, and educational materials; establish metrics focused on risk reduction to minimize the impact of climate change on military and support operations, forces, programs, and facilities; ensure climate change resilience by incorporating climate change risk in design standards for facilities and installations, with an emphasis related to energy- and water-intensive uses.

— Defense Science Board "Trends and Implications of Climate Change for National and International Security," Oct 2011

Goal 2: Utilize a robust decision making approach based on the best available science.

Assessing climate change vulnerabilities, impacts, and adaptive responses requires a deliberative and iterative approach. The Department intends to develop appropriate assessment tools for use across all affected DoD Components. In developing its approach to assessment, adaptation planning, and implementation, the Department will strive to:

- Establish a process to obtain updated scientific data on potential future climate conditions and potential impacts;
- Use commonly accepted future climate scenarios that are based on the best available science, recognize uncertainties, and updated as the science changes;
- Provide guidance so that assessments consistently apply science that is appropriate in terms of location, resolution, and timeframe; and
- Use pilot approaches to develop decision frameworks for assessment and adaptation planning that attempt to match decisions to available and appropriately down-scaled climate information and other data.

Goal 3: Integrate climate change considerations into existing processes.

Climate change and climate variability will affect many of the Department's activities and decisions related to future operating environments, military readiness, stationing, environmental compliance and stewardship, and infrastructure planning and maintenance. Climate change also will interact with other stressors that the Department now considers and manages. As a result, adaptation to climate change and variability should not be a separate decision-making process, but rather an aspect of overall management. DoD intends to fully integrate climate change considerations into its extant policies, planning, practices, and programs. Some stand-alone policy and guidance may be needed to help direct specific assessment activities and adaptation implementation; however, by and large the Department will use existing mechanisms to implement policy and guidance and to ensure mission and environmental sustainability.

Goal 4: Partner with Federal agencies and allies on the challenges of climate change.

Partnerships will be needed to fully ensure DoD's mission is sustainable under climate change. The Department cannot assess its vulnerabilities and implement adaptive responses at its installations if its neighbors and stakeholders are not part of the process. Decisions made by outside communities will affect DoD and DoD's decisions will also affect outside communities. Moreover, aspects of our mission such as force deployment may be affected by assets outside DoD control, such as transportation infrastructure.

The requisite scientific and practical understanding needs to be obtained in concert with the rest of the Federal community. This can occur through partnerships with individual agencies such as the National Oceanic and Atmospheric Administration or through the Department's continued participation in forums such as the National Climate Assessment and informal forums such as the Interagency Forum on Climate Change Impacts and Adaptations.

"In combination with U.S. diplomatic and development efforts, we will leverage our convening power to foster regional and international cooperation in addressing transnational security challenges." (pg 15)
— 2011 National Military Strategy

Internationally, the Department will continue its collaboration with the State Department and foreign militaries on vulnerability assessment and adaptation efforts. The Department has already started to assess potential climate change impacts and begin initial adaptation planning. Efforts to partner with foreign defense force counterparts are coordinated through existing planning processes. Climate change presents a unique opportunity to work collaboratively in multilateral forums, promoting a balanced approach that will improve human and environmental security in the region. The Department's disaster response programs will continue to provide domestic and international response, but should adapt its response planning based on plausible climate change scenarios.

4. Actions to Better Understand Climate Change Risks and Opportunities

DoD is already working to foster efforts to assess, adapt to, and mitigate the impacts of climate change. The Military Services are considering potential climate change vulnerabilities and impacts to their activities and infrastructure in light of their Service-specific missions and plans.

The Department looks to the Strategic Environmental Research and Development Program (SERDP), a joint effort among DoD, the Department of Energy, and the Environmental Protection Agency, to develop climate change assessment tools for DoD's installations. The DoD Legacy program can be

used in transitioning these tools for natural and cultural resources management applications. The Navy's Arctic and Climate Change Roadmaps also outline specific action items which contribute to DoD's understanding of how a changing climate can pose risks and opportunities to its mission and operations. The Air Force 2010-2030 Strategic Environmental Assessment includes discussion of climate change as a strategic consideration for Air Force strategic planners. The Army is investigating climate risks to installation lands and facilities in its Environmental Quality Technology research program, and the Army Climate Change Workgroup is developing a framework for integrating climate change considerations into existing planning processes. The Sustainable Ranges Integrated Product Team, led by an Office of the Secretary of Defense and tasked to address test and training encroachment and sustainability issues, also includes consideration of climate change as an emerging encroachment issue. As discussed earlier in this roadmap, such nascent DoD initiatives will benefit significantly when an overarching DoD policy framework can be put in place to help guide and focus such efforts.

The sections that follow summarize activities currently underway to understand the risks and opportunities to DoD operations. Some of these assessments are general and high-level, while others are specific to certain subject matter areas and/or locations.

"Our diplomacy and development capabilities must help prevent conflict, strengthen weak and failing states, lift people out of poverty, combat climate change and epidemic disease ..." (pg 11)
— 2010 National Security Strategy

4.A General Assessments

DoD is working to overlay regional climate models with installation locations, in order to appropriately downscale climate variables for individual locations and develop an analytical tool that can be used to generate climate projections at the regional level. DoD is involved in high-level climate and weather data gathering efforts, as the Air Force 14th Weather Squadron collects, stores, and characterizes earth-space environmental data, receiving nearly 500,000 weather observations and satellite-derived wind profiles each day and sharing these data with the National Climatic Data Center and the Navy's Fleet Numerical Meteorological and Oceanographic Detachment. DoD collaborates with the National Oceanic and Atmospheric Administration on the development and operational implementation of a national Earth System Prediction Capability.

4.B Coastal Risks and Opportunities

Many of DoD's military installations are concentrated in coastal regions of the continental United States. As a result, DoD is undertaking multiple projects to assess climate change impacts to these installations and areas. Several of these projects focus specifically on sea level rise and storm surge, developing the necessary methodologies and/or tools that might inform decision making processes, including where to build and how to update coastal installations. Other projects deal with climate impacts on coastal ecosystems, as the military's long-term use of coastal installations is, in part, dependent on the ability to maintain the continued functioning of coastal ecosystems. Projects that specifically address coastal ecosystems can help educate natural resource managers and enhance their decision making processes related to managing these ecosystems for their training/testing value, storm protective functions, and species diversity. The Department, drawing on the lessons learned from the preceding studies, has identified the key technical considerations to consider when conducting assessments of climate change impacts on coastal military installations. This effort will assist the Department in developing its approach to coastal assessment.

4.C Arctic Risks and Opportunities

The Department has also begun to assess and plan for changes to our operating environment. For example, preliminary assessments have been conducted for the Arctic where measurable climate change impacts are already occurring. These efforts have focused on assessing the Department's Arctic observing, mapping, and environmental prediction capabilities, as well as identifying science and technology needs. The Department has completed two Capabilities Based Assessments for Arctic surface and environmental prediction capabilities and a Fleet Readiness Assessment. The Department is developing cooperative partnerships with interagency and international Arctic stakeholders to collaboratively address future opportunities and potential challenges inherent in the projected opening of the Arctic.

4.D Permafrost in Alaska

The change in permafrost in Alaska is impacting both the built and natural infrastructure. The Department held, as early as 2009, workshops to better understand affected defense assets and military missions in Alaska. The melting permafrost will impact foundations, utilities, runways and roads. This is a challenge for operation and maintenance especially when considering 80% of the infrastructure that will exist in 2050 is already in place today. The melting permafrost influences on training lands and natural ecosystems can significantly affect the types and timing of training activities. The potential ecosystem responses in interior Alaska to climate change could have severe ramifications on how, where, and when the DoD can train in Alaska. To address concerns related to climate change's impact on permafrost freeze and thaw processes and other ecological factors in interior Alaska, DoD initiated a suite of projects in FY 2011 focused on understanding and predicting these changes and the implications for Alaskan training land sustainability. These efforts will fill knowledge gaps relative to how climate change is affecting permafrost and the overall system dynamics, informing decisions on the development of future training and installation management plans.

4.E Arid Ecosystems

Long-term use of military installations and ranges in the southwestern United States depends, in part, on the condition of local ecosystems. Changes to local ecosystems can adversely impact natural resources and affect the use of certain locations for training, and/or increase the possibility of wildfires. DoD has initiated several projects to assess changes to ecosystems in the southwestern United States, including the intermittent and ephemeral stream systems that harbor much of the region's biological diversity, and the interaction of land-use activity, altered water sources, the introduction of invasive species, and altered fire regimes.

4.F Pacific Islands

In FY 2013, DoD anticipates initiating climate change studies to assess the impacts on DoD facilities in the Pacific. Changes in sea level, precipitation, and storm patterns can have significant impact on the island infrastructure that supports DoD missions in the region.

5. Actions to Address Climate Change Risks and Opportunities

In addition to the activities outlined in Section 3, DoD's current efforts to integrate, partner, and undertake pilot activities to address climate change risks and opportunities include the following.

DoD is already beginning to incorporate climate considerations into installation-level planning, as well as training plans. The Department is starting to incorporate climate change science and strategic considerations into formal training and education. The Military Services are beginning to explore incorporating climate risk/vulnerability factors into installation development planning processes. At the DoD level, United Facilities Criteria (UFC) 2-100-01, paragraph 3-5.6.2.3 requires master planners to consider climatic changes (including but not limited to: changes in land use and population density in the vicinity of installations; changes in climatic conditions such as temperature, rainfall patterns, storm frequency and intensity and water levels) when crafting long-range installation infrastructure master plans. UFC 2-100-01, paragraph 3-5.6.2.3 specifically calls out the National Climate Assessment as a source for reliable and authorized climate change scenarios. The Department's Natural Resources Conservation Program Instruction (DoDI 4715.03) requires installation natural resources management plans (INRMP) to assess the potential impacts of climate change on natural resources and to adaptively manage such resources to minimize adverse mission impacts.

As part of its Sustainable Ranges Initiative, DoD has conducted research and completed an initial study of potential climate change vulnerabilities affecting DoD training and potential adaptive measures. Additional research and coordination is ongoing, and several workshops have been held to engage with DoD offices and Federal agencies on possible avenues to foster a more adaptive individual and organizational culture that is better prepared to respond to mission stressors such as climate change. DoD is also actively engaged with regional partnerships in the Southeastern and the Southwestern U.S. Both regions are very significant to

"We must, therefore...design structures and systems that can withstand disruptions and mitigate associated consequences, ensure redundant systems where necessary to maintain the ability to operate, decentralize critical operations to reduce our vulnerability to single points of disruption, develop and test continuity plans to ensure the ability to restore critical capabilities, and invest in improvements and maintenance of existing infrastructure." (pg 27)

--- 2010 National Security Strategy

DoD, and host a number of major military installations and ranges. The aim of both the Southeast Regional Partnership for Planning and Sustainability and the Western Regional Partnership is to strengthen regional coordination and advance the missions and land use objectives of DoD and the other state and Federal agencies involved. Both partnerships are actively assessing the climate change challenge, along with a number of other often interrelated issues (habitat and species protection, land use planning, energy development, coastal zone management, fire management and disaster preparedness, and sustainable land use) as they work on cooperative policy and planning initiatives. DoD expects cooperation on climate change issues to continue and likely grow in importance within both partnerships in coming years.

Through SERDP, DoD has initiated pilot projects intended to develop and test assessment approaches and decision-making frameworks for climate adaptation appropriate for military installations. These pilot efforts will help DoD identify appropriate processes for matching climate information with DoD decision processes, understanding data needs for vulnerability assessments, and developing adaptation tools with installations across the country.

